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# **Simulation and Analysis Support of Counter Mine/Counter Obstacle System Development**

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Panama City



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# Brief Structure

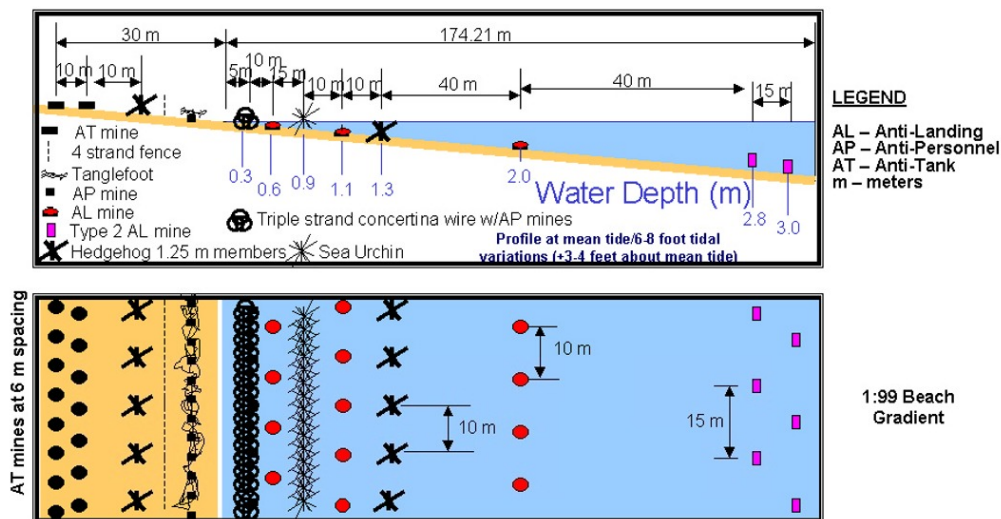




# The Problem

## ■ Threats to Amphibious Operations

- Anti-Tank, Landing and Personnel Mines
- Wire and obstacles
- Hard to defeat in the BZ/SZ
- *Quick, easy, cheap and effective*





# Threat Demonstration

- **Amphibious Assault Vehicle (AAV) vs. PDM-2B mine**
  - **AAV floating & restrained in a test pond; no armor installed**
  - **PDM-2B is a Bulgarian moored mine with approximately 35 lbs. of cast TNT**
  - **Mine tethered to the bottom of pond & floated 10 feet above the bottom & just beneath the chin of the AAV, a realistic position for the encounter**
  - **PDM-2B fuze not used in this test; event was electrically initiated**





# AAV vs. PDM-2B Results

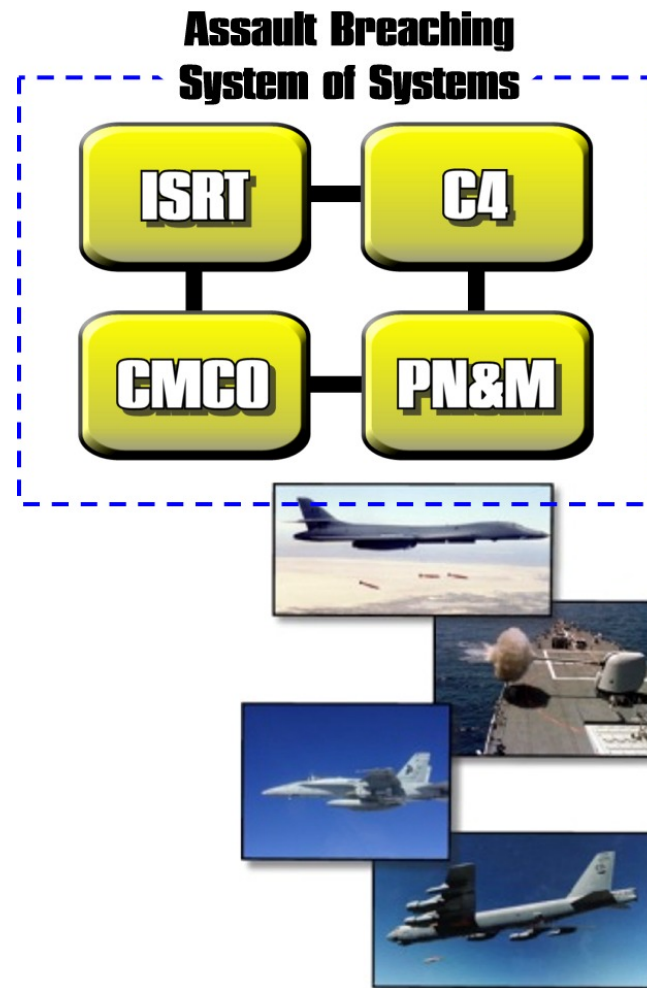


*If we can't overcome the Surf/Beach Zone threat, the STOM concept is unobtainable.*



# Solution - ABSoS

- **Assault Breaching System of Systems (ABSoS)**
  - **ISRT** – Intelligence, Surveillance, Reconnaissance and Targeting
  - **C4** – Command, Control, Communications and Computers
  - **CMCO** – *Counter Mine, Counter Obstacle*
  - **PN&M** – Precision Navigation and Marking
  
- **CMCO System Objectives**
  - Neutralize mines and obstacles in the
    - Surf zone (SZ): 10-foot water depth to high water mark (HWM)
    - Beach zone (BZ): HWM to beach exit
  - Stand-off delivery of the CMCO warheads





# CMCO Candidate Systems

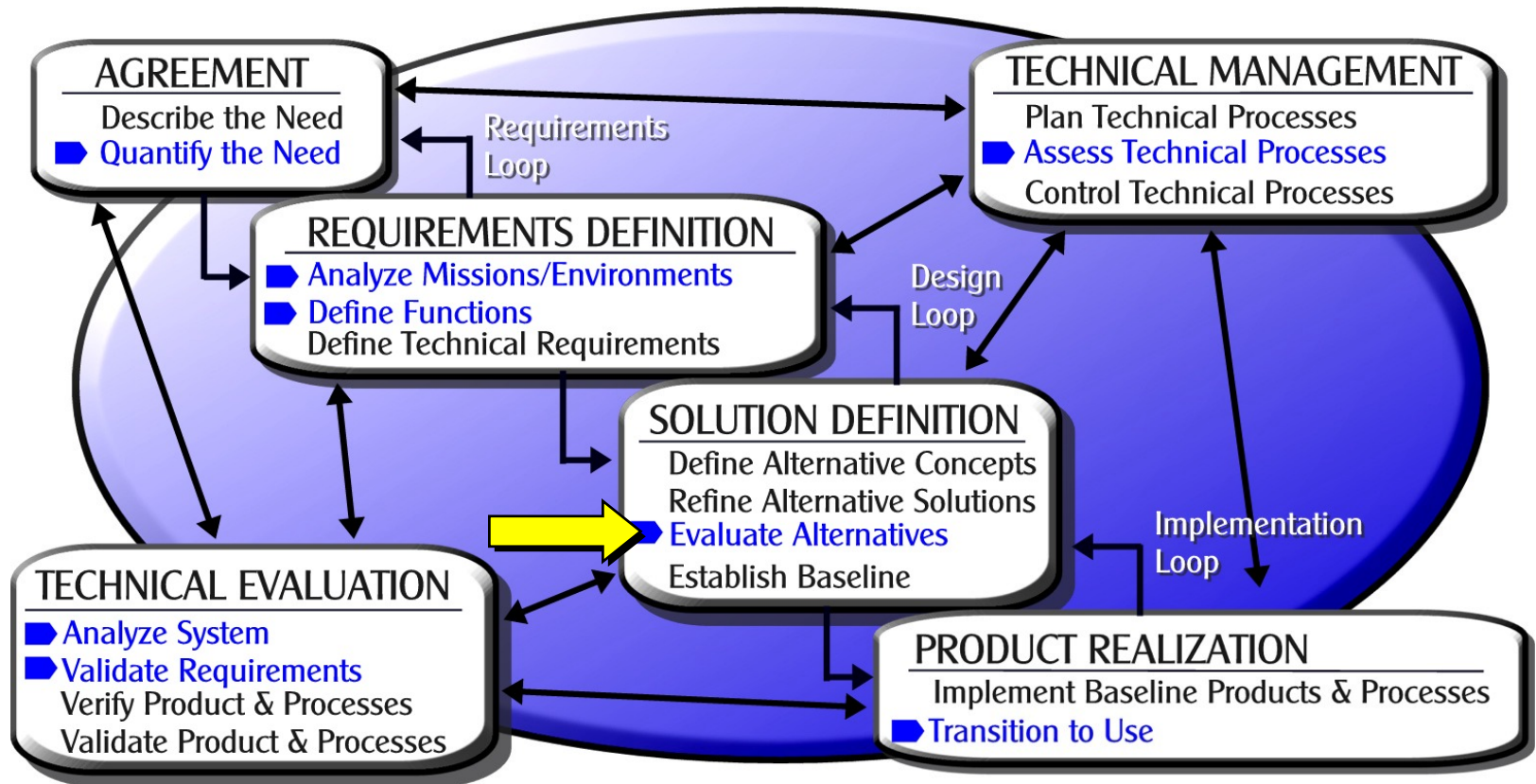
- **Near-Term Effort (FY06 Goal)**
  - **Joint Direct Attack Munition (JDAM) Assault Breaching System (JABS)**



- **Mid-Term Concepts (FY15)**
  - **Three under evaluation**
    - Two air-dropped
    - One naval gun-launched
  - **Chemical or explosive penetrators against mines in the SZ and BZ**
  - **JABS continues as the counter-obstacle weapon**



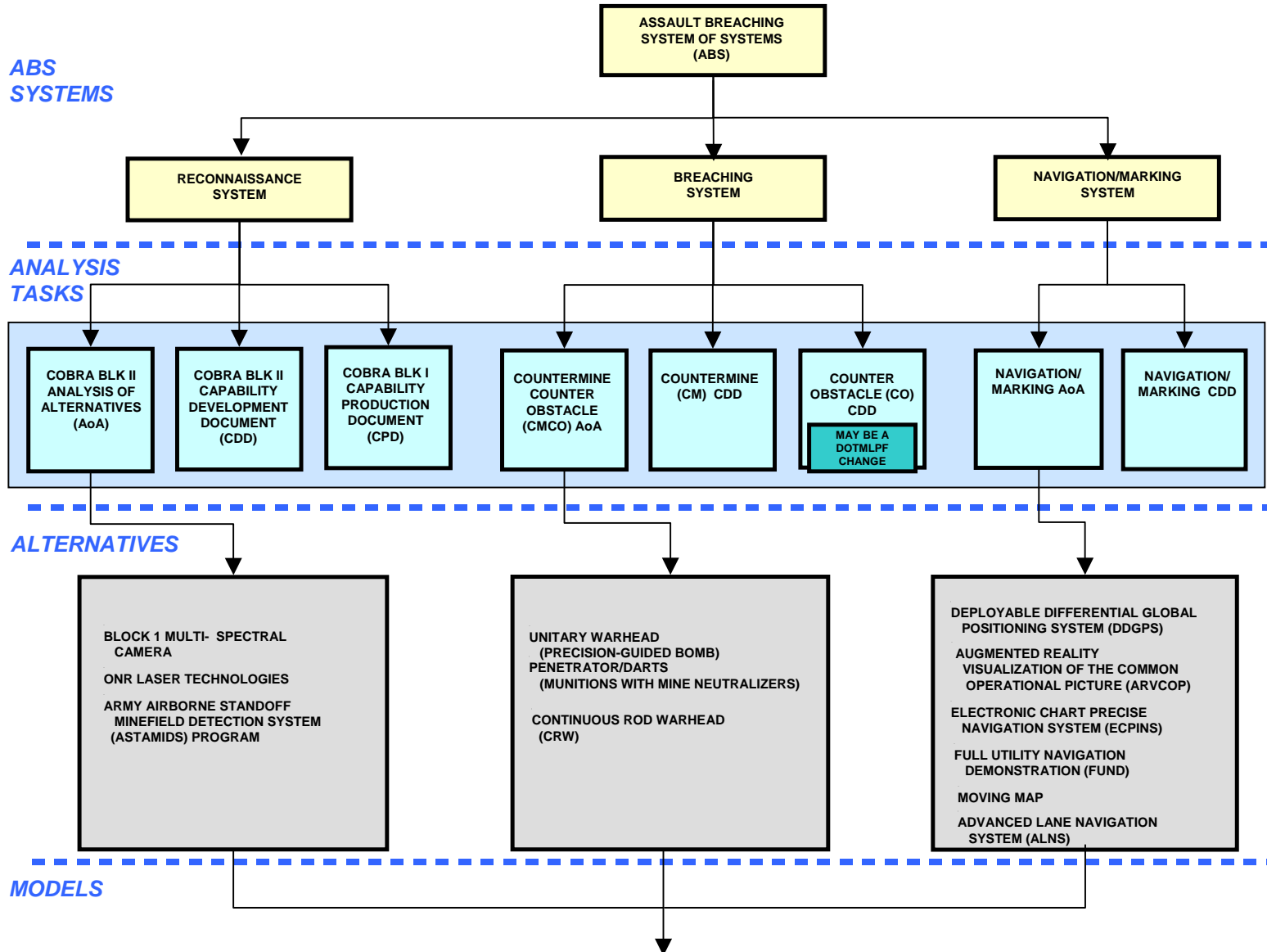
# Warfare Analysis in System Engineering



*Blue highlights are simulation supportable activities.*



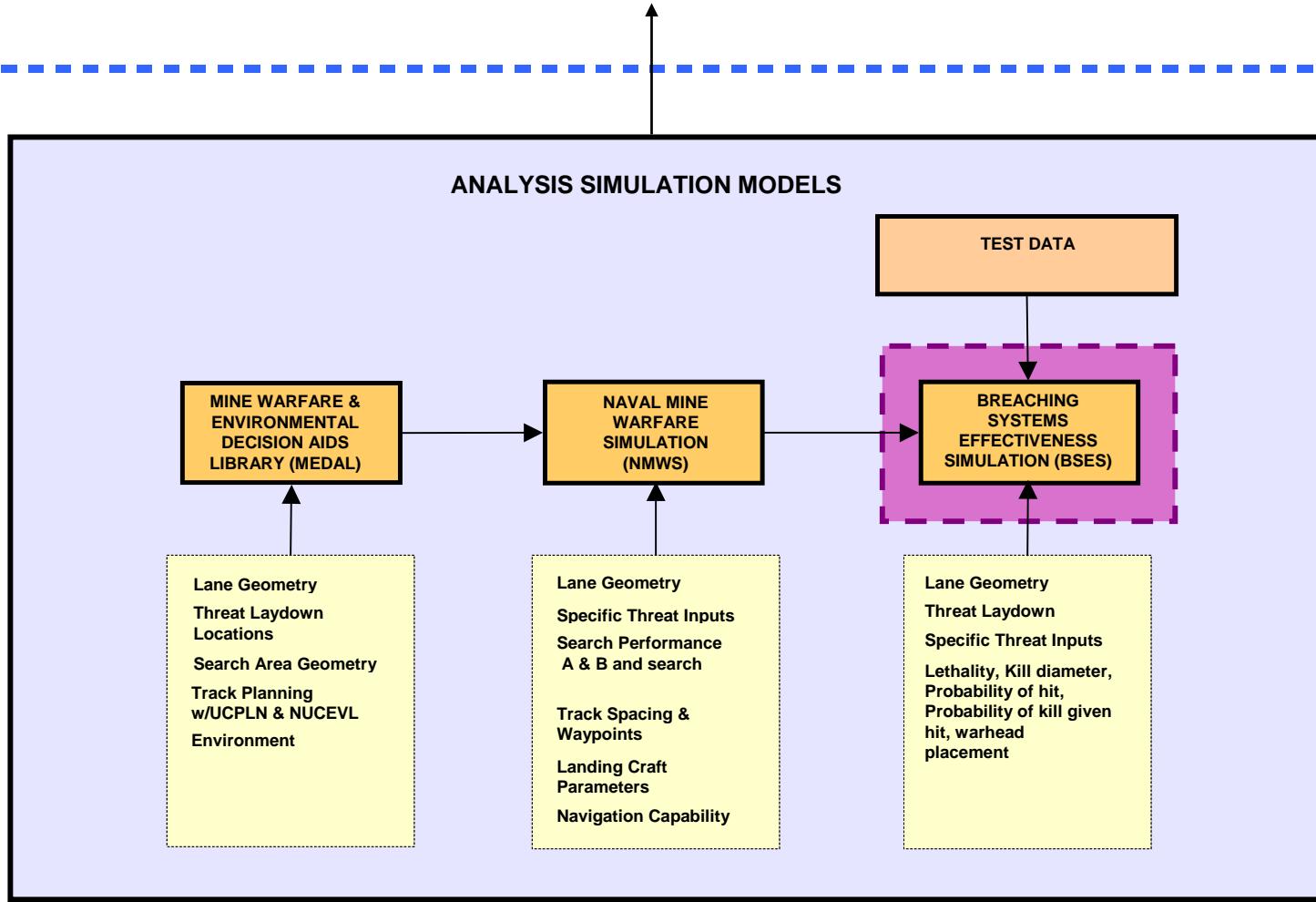
# ABS Analysis Approach





# ABS Analysis Approach (cont.)

MODELS





# Simulation Goals



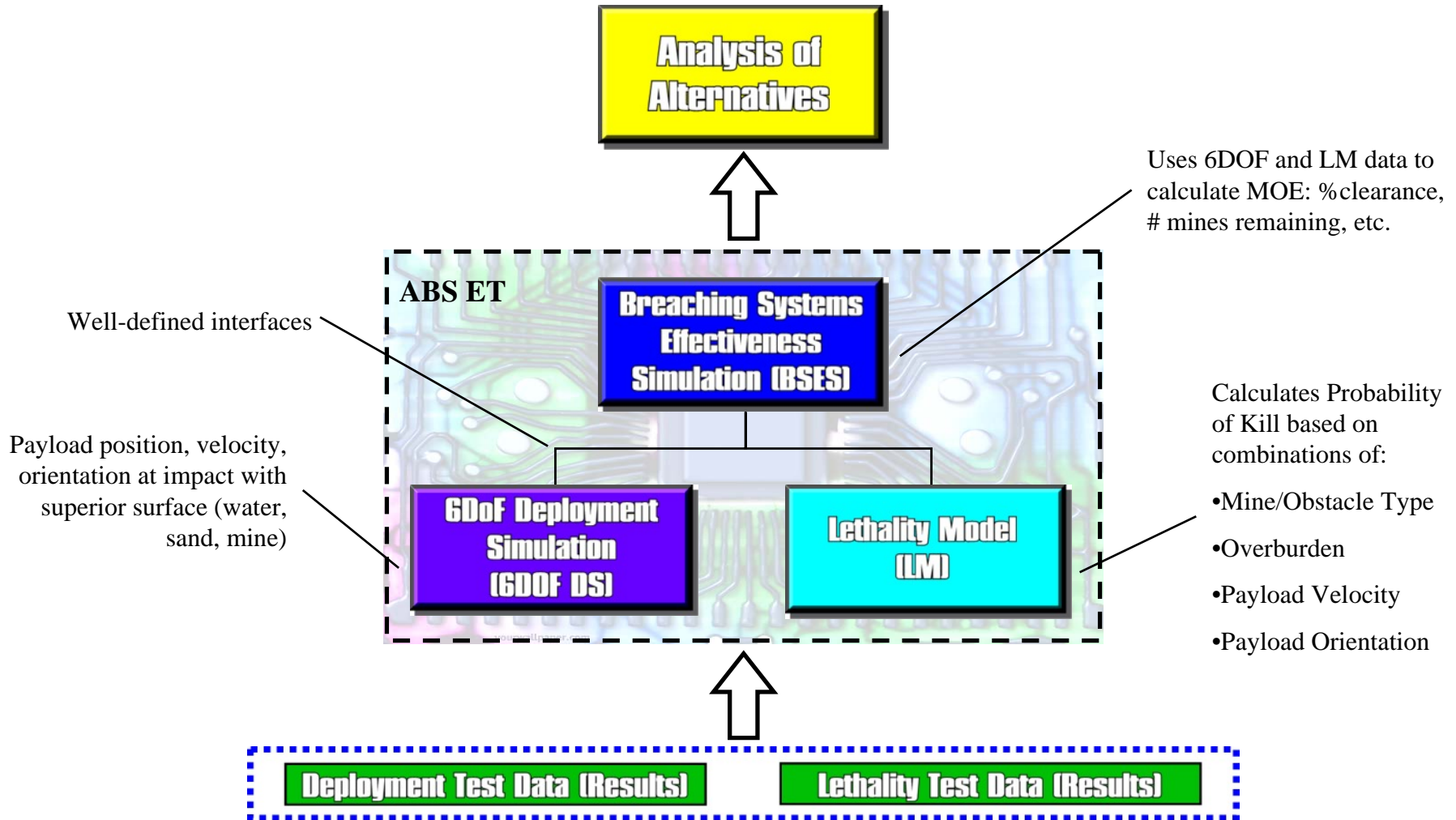
## ■ Primary Goals:

1. To provide a simulation toolset by which analysts may perform Analysis of Alternative (AoA) studies for development of the Assault Breaching System of Systems (ABSoS) concept.
2. To assist analysts and engineers in analyzing far term shallow water mine countermeasure systems in the Research Development Testing and Evaluation (RDT&E) phase for effectiveness against mine and obstacle threats in the Surf and Beach Zones.
3. To be adaptable and extensible in support of future AoA and planning tasks.



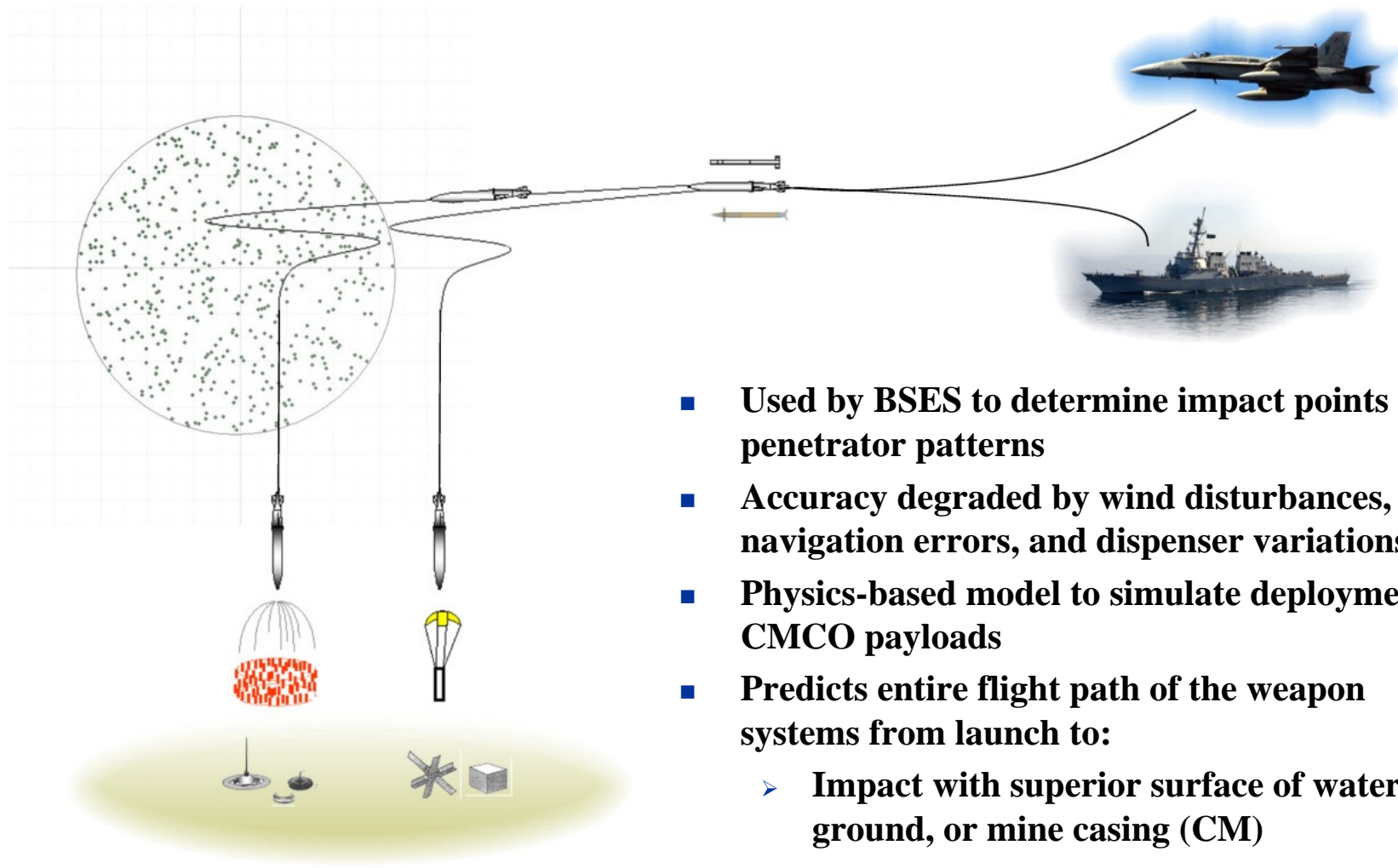


# ABS Effectiveness Toolset Concept





# 6DOF Model

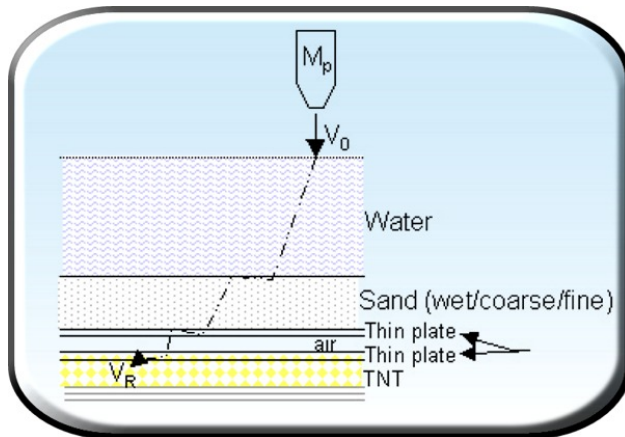


- Used by BSES to determine impact points and penetrator patterns
- Accuracy degraded by wind disturbances, navigation errors, and dispenser variations
- Physics-based model to simulate deployment of CMCO payloads
- Predicts entire flight path of the weapon systems from launch to:
  - Impact with superior surface of water, ground, or mine casing (CM)
  - Reaching burst height (CO)



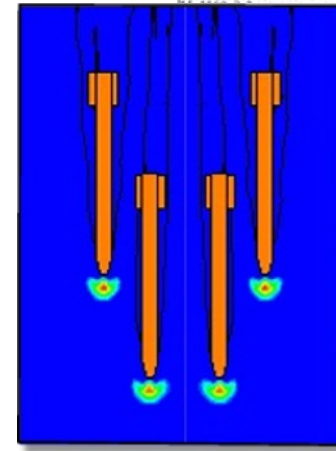
# Lethality Model

- Used by BSES to determine mine kills
- Set of  $P_k$  Lookup Tables for every Penetrator, Mine, & Overburden Combination
- Generated with Physics-based VENPEN Penetration Model
  - Library of Penetrator Shapes
  - Updated Material Library: Coarse Sand, Concrete & Brick
  - Super Cavitation Model: Cavitational Effects on Adjacent Darts
- Based on Results of Lethality Testing



```
def initform
  *vxy = transverse impact velocity in xy-plane = SQRT(Vx^2 + Vy^2)
  *vz = vertical impact velocity
  *angle = impact angle (0 deg is vertical, + in same direction as +vxy)
  *pk = probability of kill

vxy (fps), vz (fps), Angle (deg), pk
0.1160,10.1
0.1160,10.1
10.1160,10.1
15.1160,10.1
20.1160,10.1
25.1160,10.1
30.1160,10.1
0.1160,8.1
5.1160,8.1
10.1160,8.1
15.1160,8.1
20.1160,8.1
25.1160,8.1
30.1160,8.1
0.1160,6.1
5.1160,6.1
10.1160,6.1
15.1160,6.1
20.1160,6.1
25.1160,6.1
30.1160,6.1
0.1160,4.1
5.1160,4.1
10.1160,4.1
15.1160,4.1
20.1160,4.1
25.1160,4.1
30.1160,4.1
0.1160,2.1
5.1160,2.1
10.1160,2.1
15.1160,2.1
20.1160,2.1
25.1160,2.1
30.1160,2.1
```





# The BSES Model

## Mission Definition

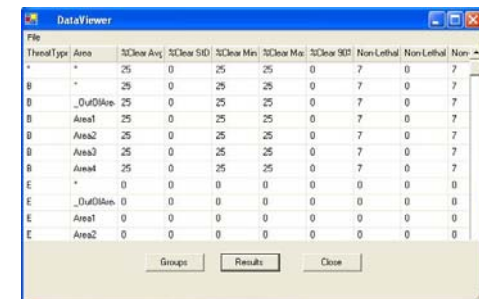
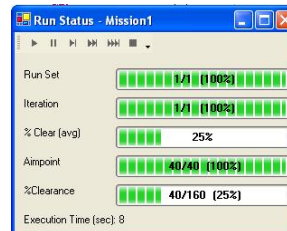
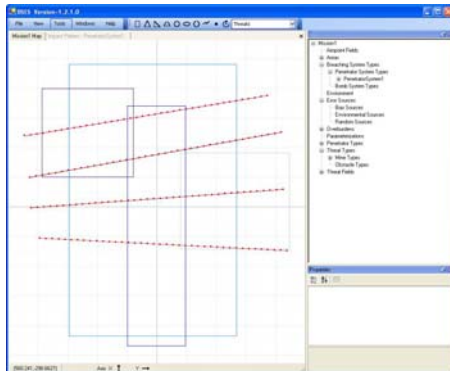
- Threat types, locations and overburdens
- Bomb and penetrator type
- Weapon error budget
- Impact patterns (6DOF)
- Lethality data (Lethality Model)
- Lanes
- Aim points

## Simulation Iterations

- Monte Carlo
- Uncertainty in Threat location
- Apply error and reliability probabilities to aim points
- Aim point interaction with threats
- Determine lethality
- Record hits and kills

## Reporting & Analysis

- Data viewer
- Processing and correlation as defined by analyst's needs
- Supports AoA tasks



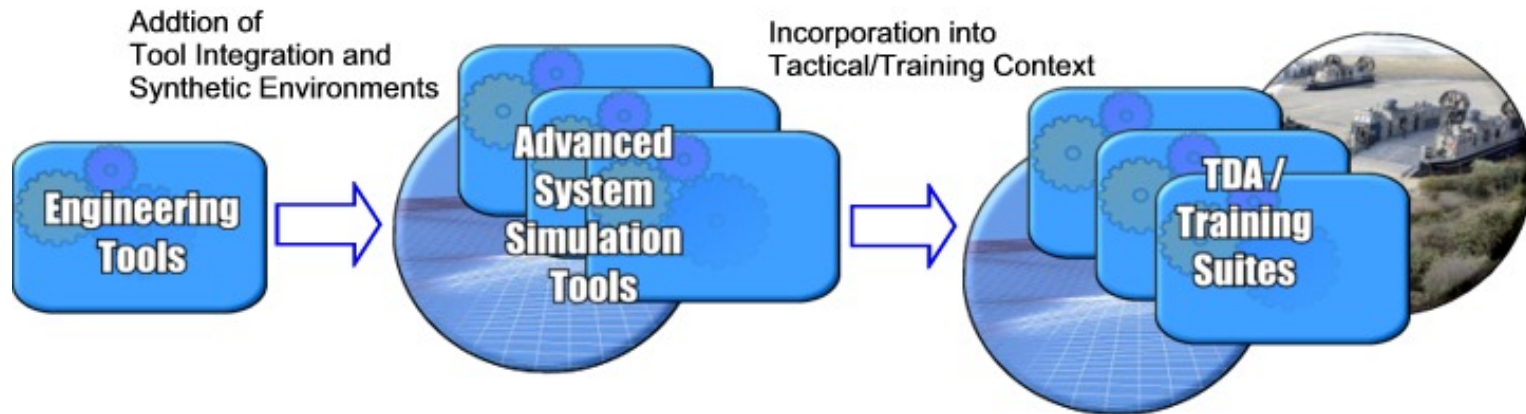
The screenshot shows the 'DataViewer' window with a table of simulation results. The table has columns for Threat Type, Area, %Clear Avg, %Clear SID, %Clear Min, %Clear Max, %Clear 90%, Non-Lethal, and Non-Lethal. The data is organized into groups for different threat types and areas.

Threat Type	Area	%Clear Avg	%Clear SID	%Clear Min	%Clear Max	%Clear 90%	Non-Lethal	Non-Lethal
*	*	25	0	25	25	0	7	0
B	*	25	0	25	25	0	7	0
B	_OutDir	25	0	25	25	0	7	0
B	Area1	25	0	25	25	0	7	0
B	Area2	25	0	25	25	0	7	0
B	Area3	25	0	25	25	0	7	0
B	Area4	25	0	25	25	0	7	0
E	*	0	0	0	0	0	0	0
E	_OutDir	0	0	0	0	0	0	0
E	Area1	0	0	0	0	0	0	0
E	Area2	0	0	0	0	0	0	0

*Parametrically driven models are flexible enough to support new operational and system experimentation.*



# TDA/Training Support

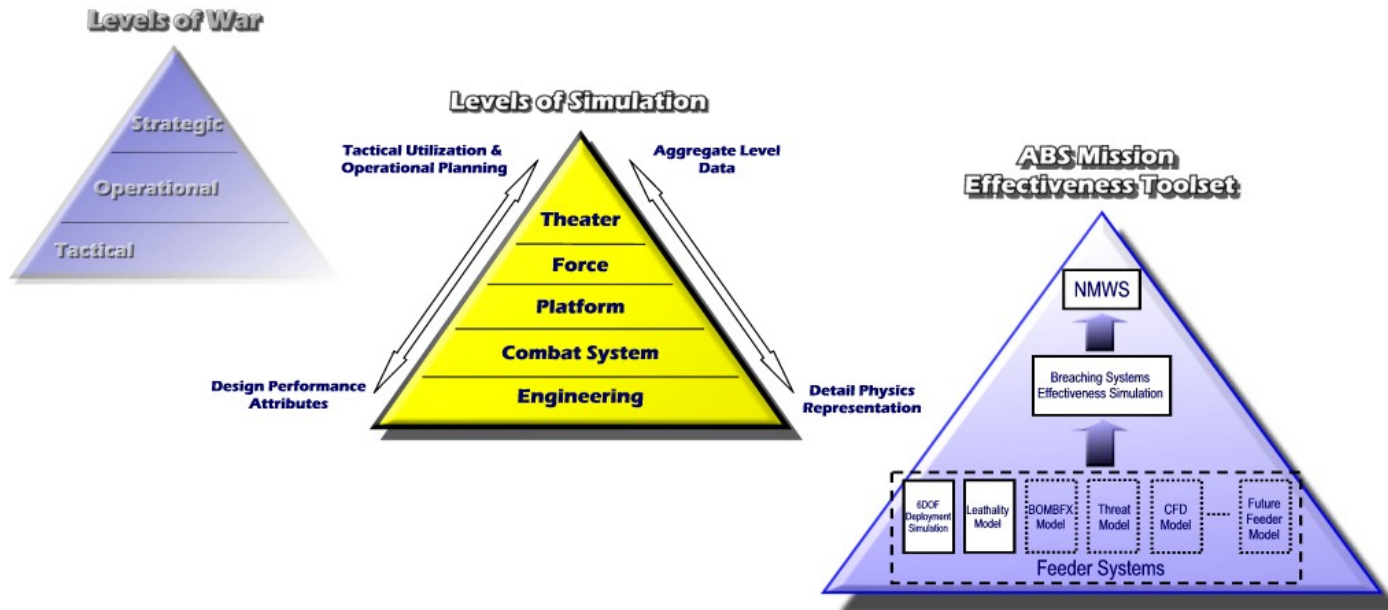


- Built on high fidelity physics-based engineering models to describe the behavior of the sub-systems.
- Integration and emersion into a synthetic environment to create advanced simulation tool sets that are used for AoA and CONOPS studies.
- Models may be leveraged in to tactical decision aids and training suites by the incorporation of situational context and rules.

*Lower-level simulations are integrated together as building blocks toward higher-level capabilities.*



# Higher Level Simulation Support



While the initial use will be that of an analysis tool for comparison of all far-term system concepts during the AOA, the 6DOF DS and Lethality Models are two of many possible “Feeder Systems” that may add input into the BSES at a future date. BSES will then, in turn, be used as a feeder system into the theater level Naval Mine Warfare Simulation.



# ROI?

As an example, one live-fire test incurred more expense than all of BSES development and provided minimal statistical certainty. However, live-fire testing is still needed to validate models.

	Live-Fire Test	BSES
COST	<ul style="list-style-type: none"><li>- China Lake Range preparations</li><li>- Pond in the desert</li><li>- Safety</li><li>- B-52s</li><li>- Weapon Systems</li><li>- Targets</li><li>- Logistics</li></ul>	<ul style="list-style-type: none"><li>- Initial development cost</li><li>- Minimal labor and hardware support</li></ul>
QUALITY	<ul style="list-style-type: none"><li>- Minimal environmental control</li><li>- Geographically limited</li></ul>	<ul style="list-style-type: none"><li>- Complete control of test environments</li><li>- No geographic/political/safety/cost/schedule restraints on test scenarios</li></ul>

*Validated simulation models allow unrestricted test scenarios while maintaining complete control of mission parameters.*



# Contact Information



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